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United States Patent Application

for

CORDLESS SURGICAL HANDPIECE WITH DISPOSABLE BATTERY; AND METHOD

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Claiming the Benefit of
Application S. N. 09/349,643 filed 07/08/99
and
Prov. Appln. 60/112,678 filed Dec. 16, 1998

Assigned to Medtronic, Inc.

1 CORDLESS SURGICAL HANDPIECE WITH DISPOSABLE BATTERY; AND METHOD
2

3
4 PRIORITY CLAIM
5
6

7 This application claims the benefit of our prior copending
8 application S. N. 09/349,643 filed 07/08/99 and of our
9 Provisional Application 60/112,678 filed Dec. 16, 1998
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11 FIELD OF THE INVENTION
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13 The present invention relates to electrically operated
14
15 surgical tools and methods of their use.
16

17
18 BACKGROUND OF THE INVENTION
19

20 An important economic factor for any surgical tool or
21 machine is the amount of unproductive time spent in its
22 operation. This comes in the form of training and initial set-
23 up. Before a surgical procedure begins, the users need to know
24 how to operate the instrument and be familiar with all its
25 controls. Hospital personnel must set up the instrument system
before it can be used. This involves connecting all the power
lines, calibration, and verifying function. Both user's training
and instrument system set-up entail time and cost by the medical
facility.

26 The most unique aspect of surgical equipment is the need for
27 sterility. To prevent infections and to aid healing, surgical
28 equipment is sterilized. The effort this takes and the success

1 with which it occurs varies depending on the equipment. The
2 maintenance of sterility in the surgical site is a major factor
3 in health care. Non-sterile or partially sterile instruments may
4 be considered to harbor bacteria or toxic debris. Each of these
5 will lead to an inflammatory response from the body and
6 associated infection, carcinogenesis and cell necrosis.
7 Contamination will lead to grave systemic effects on the patients
8 of orthopedic surgery, which by its nature is highly invasive.
9 The maintenance of a sterile operating field is of prime
10 importance in surgical handpieces.

11 CORDED INSTRUMENT SYSTEMS

12 The use of a corded instrument system dictates that only one
13 handpiece may be used at any one time per console. When another
14 instrument is needed the console cord must be switched to another
15 instrument. Procedures where it is imperative that two
16 instruments be used simultaneously necessitate two consoles.
17 Handpiece instrument consoles are expensive and the need for
18 duplication is a distinct disadvantage. Disconnecting and
19 reconnecting instruments to the console cord takes a certain
20 amount of work and time. Using cordless instruments reduces
21 instrument transfer time.

22 A reusable cord must be properly sterilized prior to
23 surgery in an expensive and complex in-house sterilizer. Once
24 sterile, the cord must be carefully transported to the operating
25 room. There the cord becomes partially non-sterile due to its
26 console connection.

1 When a corded handpiece is transferred and exchanged to
2 other medical personnel, the cord must be handled. However,
3 there is no way to tell which part of cord has fallen out of the
4 sterile field. This poses an increased risk of contamination to
5 the user and the surgical site.

6 When multiple handpieces are exchanged they are extensively
7 handled. This is because the cord must be disconnected and
8 reconnected to each handpiece. Handling increases the risk of
9 contamination. This risk is greatly minimized with cordless
10 instruments.

11 Following a surgical procedure, the instrument cord needs to
12 be thoroughly cleaned prior to its next use. This involves
13 cleaning blood and tissue off the cord with powerful solvents and
14 cleaners. These agents attack the cord and limit its useful
15 life. The cord must be handled by trained medical personnel.
16 A disposable power pack would eliminate these extra tasks and
17 their associated costs.

18

19 CORDLESS INSTRUMENTS

20 During a surgical procedure it is often necessary to use
21 more than one handpiece. Saws and high speed handpieces are
22 used for cutting, shaping and in general removing portions of
23 bone. Drills are used primarily for making holes, which are
24 then used for inserting wires, pins or screws. These two
25 operations are often used in conjunction with one another during
26 bone and tissue repair procedures. Current pencil grip surgical

1 instruments make it difficult to use more than one instrument at
2 a time during a surgical procedure.

3 A cordless handpiece is easier for the physician to operate
4 than similar corded handpieces. The controls are basic and are
5 controlled with one hand. Equivalent corded handpieces require
6 complex console instructions and commands.

7 A further advantage of cordless handpieces is the greater
8 ease of set-up. Equipment set-up is a significant time issue for
9 hospitals. Corded systems have complicated and time-consuming
10 assembly procedures. Multiple connections are involved. A user
11 must be trained at setting up and operating the console system.

12 In instances where a powered surgical instrument is needed
13 immediately, a cordless instrument can be immediately transported
14 to that area. This is true regardless of the surrounding
15 environment. That is not true of a corded unit.

16 A surgical instrument cord, connected to a non-sterile
17 console, may be considered only partially sterile. This by
18 itself compromises the integrity of a surgical site. A cordless
19 handpiece maintains sterility throughout the entire surgical
20 operation.

21 Surgical procedures often involve cuts at more than one
22 position at a surgical site. A convenient way to accomplish this
23 is to pass the surgical instrument over the surgical site. With
24 a corded instrument, this would unfortunately result in the cord
25 being passed over, and perhaps falling into, the surgical site.
26 The resulting tissue damage and contamination can have grave

1 consequences. A cordless instrument can easily be passed over
2 the surgical site without contamination risks. Likewise, a
3 physician who needs to make multiple cuts or holes at various
4 surgical locations needs to be in the position that best suited
5 him or her without trailing a bulky, cumbersome partially sterile
6 cord.

7 Cordless instruments have heretofore utilized batteries of
8 the rechargeable type. This adds special problems, because the
9 battery must be sterilized before use; and after each use it must
10 be recharged and then sterilized in preparation for the next use.
11 Presently available batteries do not lend themselves well to this
12 process.

SUMMARY OF THE INVENTION

According to the present invention a method of performing surgery is provided, in which bone or hard tissue may be cut, shaped, or drilled by means of a cordless powered surgical instrument, but without the necessity of subsequently recharging a battery or re-establishing its sterile condition.

According to the invention a disposable battery pack can be easily connected to a surgical instrument, both electrically and mechanically, and after a single use may be detached and safely disposed of as non-hazardous waste, into the waste system.

24 Further according to the invention a method of performing a
25 surgical procedure is disclosed, utilizing a cordless surgical
26 handpiece powered from a sterile battery pack in which the

1 battery chemistry is based upon lithium/manganese dioxide, the
2 battery being in condition for immediate use without further
3 charging or sterilization, and being adapted after a single use
4 to be disposed of into non-hazardous waste.

5 Still further according to the present invention a surgical
6 handpiece and disposable battery are provided with mating sets of
7 electrical contacts which can be mechanically and conductively
8 locked together to ensure correct alignment of the parts, as well
9 as stable mechanical support and reliable electrical operation of
10 the handpiece during the surgical procedure.

11 According to yet another feature of the presently preferred
12 form of the invention, a surgical handpiece and a disposable
13 battery each has a defined longitudinal axis with a set of
14 electrical contact elements arranged generally concentric to that
15 axis, and when those parts are aligned on a mutual longitudinal
16 axis the sets of contacts are adapted to become lockingly and
17 conductively interengaged in response to rotation of the battery
18 pack relative to the handpiece.

19 Still another feature of the invention is that when using a
20 compact surgical handpiece with a brushless DC motor and a
21 manually operated external trigger for activating and controlling
22 the motor operations, a compatible disposable battery may also be
23 used, with interengaging sets of contacts on the handpiece and
24 battery adapted to become lockingly and conductively interengaged
25 upon rotation of the battery pack relative to the handpiece in a
26 manner that rapidly achieves correct alignment of the parts and

1 also ensures stable mechanical attachment and support during the
2 surgical procedure.

DRAWING SUMMARY

4 Fig. 1 (a) is a schematic view of a surgical handpiece in
5 accordance with the invention, showing disposal of an associated
6 battery pack into non-hazardous waste after it has been used;

7 Fig. 1 (b) is a cross-section view taken on the Line 1(b) --
8 (1 (b) of Fig. 1 (a), showing that the battery pack when being
9 disposed of still contains batteries;

10 Fig. 2 is a perspective view of a sterile battery pack in
11 its plastic () container, in accordance with the invention;

12 Fig. 3 is an exploded perspective view of the handpiece and
13 battery pack before they are assembled together;

14 Fig. 4 is a perspective view of the instrument assembly
15 during attachment of the battery pack, with arrows indicating the
16 direction of movement of the battery pack;

17 Fig. 5 is a perspective view of the instrument assembly
18 after attachment of the battery pack, with arrows showing that
19 the battery pack has been rotated by ninety degrees;

20 Fig. 6 is a rear end view of a surgical drill or handpiece
21 in accordance with the invention taken along line 6-6 of Fig. 3;

22 Fig. 7 is a front end view taken along line 7-7 of Fig. 3 of
23 the disposable battery pack;

24 Fig. 8 is a longitudinal cross-sectional view showing
25 initial alignment of the battery pack to the surgical drill

Fig. 9 is a cross-sectional view like Fig. 8, but showing

1 the battery pack after its full insertion and its rotation into a
2 locking attachment;

3 Fig. 10 is a perspective view of the battery pack showing in
4 detail its forward end;

5 Fig. 11 is a perspective view of the batteries contained
6 within the battery pack;

7 Fig. 12 is a side elevation view of the battery pack; and

8 Fig. 13 is a perspective view of a complete instrument
9 showing an alternate form of trigger for handpiece control.

10

11 DETAILED DESCRIPTION

12 In Fig. 1(a) and 1 (b) a surgical handpiece 10 with housing
13 12 has a rearward or base end 14, an externally mounted trigger
14 16, and a tool 18 on its forward end. A disposable battery pack
15 20 has a housing 22 and contains internal batteries 24. Arrow 30
16 indicates the disposal of battery pack into a waste basket 32
17 after the surgical handpiece has been used in a surgical
18 procedure.

19 As is conventional, the surgical handpiece is a compact
20 device containing a brushless DC motor for moving the tool member
21 18, a manually operated trigger 16 used for activating motor
22 control operations, and an adjustable tool support mechanism for
23 orienting the tool 18 and securing it in place. An electronic
24 circuit, not specifically shown, controls and regulates the
25 energy supply to the motor, and is operated externally by the
26 trigger 16. Trigger 16 may also control the range of speed, the

1 direction of the cutting tool, and cutting tool braking.

2 According to the present invention the energy supply for the
3 handpiece is provided by the battery pack 20 which is secured
4 onto the handpiece by means of a rotating movement. This
5 detachable DC electric energy supply ensures correct orientation
6 of the electrical contacts in the battery to those for the
7 handpiece, and also signals to the operator by sound, sight, and
8 touch that the battery is correctly secured in place.

9 The battery pack 20 is pre-sterilized and packaged for
10 immediate use in a surgical environment. Fig. 2 shows a plastic
11 cover 26 which is preferably used to enclose the battery pack
12 prior to its use. The battery pack 20 consists of primary
13 batteries 24 which by definition do not require charging before
14 use. These batteries retain their initial charge for long
15 periods of time. The battery pack is discarded after use and may
16 be considered a disposable component of the instrument system.

17 Further according to the invention the battery pack
18 preferably contains primary batteries 24 whose chemistry is based
19 upon lithium/manganese dioxide, such as the DL 2/3A manufactured
20 by Duracell, Inc. of Bethel, Connecticut. These batteries
21 possess a high energy density, have a high rate capability over a
22 broad temperature range, and have excellent capacity retention.

23 As shown in Fig. 3 the handpiece 10 at its rearward or
24 battery receiving end 14 has an alignment post 40 extending
25 therefrom, which defines a longitudinal axis of the handpiece.
26 It also has a set of electrical contact elements 42a and 42b

1 which are concentric to that axis. The sterile and disposable
2 battery pack 20 has an attachment end 50 with a central opening
3 52 therein, the opening 52 also defining a longitudinal axis of
4 the battery pack. The battery pack 20 also has a set of
5 electrical contact elements 54 which are concentric to its
6 longitudinal axis. The central opening 52 in the disposable
7 battery pack 20 is adapted to insertably receive the alignment
8 post 40 so as to establish a mutual alignment axis of the
9 handpiece 10 and battery pack 20.

10 The battery receiving end of the handpiece 10 also has
11 flat end surface surfaces 44a and 44b which are adapted to be
12 engaged by the battery pack. The forward or attachment end of
13 the disposable battery pack has a flat end surface 56 adapted for
14 abutting engagement with the end surfaces 44a and 44b while yet
15 allowing relative rotation of the battery pack relative to the
16 handpiece.

17 The set of contacts 42a and 42b on the battery receiving end
18 of the handpiece and the set of contacts 54 on the attachment end
19 of the disposable battery pack are mating sets of electrical
20 contact elements, each set being arranged generally concentric to
21 the mutual alignment axis. Upon the insertion of the alignment
22 post 40 of the handpiece into the opening 52 of the battery pack,
23 the sets of mating contacts are adapted to then become lockingly
24 and conductively interengaged in response to rotation of the
25 battery pack relative to the handpiece.

26 In operation, the post 40 is first partially inserted into

1 opening 52 to establish alignment of battery and handpiece. Then
2 with further insertion, the two sets of contacts will assume a
3 position in concentric relation to their common mutual axis of
4 alignment.

5

6

THE INTERLOCKING PARTS

8 Referring now to Figs. 3, 6, 8, 9, and 12, the detailed
9 structure of the rearward end of handpiece 12 is shown. Rearward
10 end 14 of the housing of handpiece 12 has an aluminum cover. An
11 end plate 60 made of aluminum closes the rearward end of
12 handpiece housing, as best seen in the cross-section views of
13 Figs. 8 and 9. End plate 60 is recessed inwardly from the
14 extreme rearward end of the housing.

15 There are a pair of electrical contacts 42a and 42b which
16 protrude out from end plate 60. Those contacts do not support
17 themselves, however; a plastic cylinder 62 is secured to end
18 plate 60, and the contacts 42a 42b, are secured to the outer wall
19 of plastic cylinder 62, about 180 degrees apart. One contact is
20 of course positive, and the other negative.

21 The rearward end of the handpiece also has flanges that are
22 part of and protrude outward from end plate 60 to control the
23 insertion and locking of the battery pack, designated on Fig. 3
24 by numerals 44a and 44b. On the left side as seen in Fig. 3,
25 **there is a wide gap** between 44a and 44b. On the right side as
26 seen in Fig. 3, there is a **narrow gap**. The flanges are

1 preferably formed as an integral part of the end plate 60, as
2 shown in Fig. 8. A stop pin 65 seen in the upper right portion
3 of Fig. 6 protrudes inwardly behind flange 44b and limits the
4 rotation of the battery contacts relative to the handpiece.

5 The front end of battery pack 20 is shown in Figs. 3, 7, 8,
6 9, and 10. It has a front end plate 70, formed of plastic
7 material, such as ABS plastic; see Fig. 8. End plate 70 also has
8 a projecting ring 72, with flanges 74, 76. As best seen in Fig.
9 3, flange 74 on the near side of the battery pack will fit into
10 the gap between lower flange 44a and upper flange 44b of the
11 handpiece, which gap is also on the left as seen in Fig. 3.

12 The other flange 76 on far side of battery pack will fit
13 between flanges 44a, 44b on the far or right side of the
14 handpiece as seen in Fig. 3. However, flange 74 is **too wide** to
15 enter the gap on the right side as seen in Fig. 3. Therefore,
16 battery pack 20 must be engaged with the handpiece in a
17 predetermined relative position.

18 Fig. 8 shows alignment of the two parts of apparatus on
19 their mutual longitudinal axis as the post 40 makes its initial
20 entry into the center hole 52 of the battery pack. Further
21 insertion of the post ensures the coaxial alignment of the two
22 parts.

23

24 ROTATING THE BATTERY PACK TO LOCKED POSITION

25 Then battery pack 20 is rotated to the right, as indicated
26 by arrows 80 in Figs. 3, 4, and 5. Fig. 5 shows the locked

1 position, also shown in more detail in Fig. 9. Further rotation
2 of the battery pack relative to the handpiece is prevented by the
3 stop pin 65. The contact elements 42a and 42b are made as spring
4 members, so that when the contact elements 54 of the battery pack
5 are seated, there is an audible noise to tell the operator that
6 the properly aligned operating position has been reached. Thus
7 the apparatus includes means providing a spring-supported snap
8 action so that the sets of mating contacts become lockingly and
9 conductively interengaged in response to rotation of the battery
10 pack relative to the handpiece.

11 It will also be noted that the battery receiving end of the
12 handpiece, and the attachment end of the battery pack, each has a
13 non-circular external cross-sectional configuration. Thus in the
14 presently preferred embodiment of the invention the two housings
15 are essentially square with rounded corners. The two external
16 configurations are closely similar in both size and shape, and
17 the rotational position of the battery pack when the contacts are
18 locked together is such that the handpiece and the battery pack
19 then provide an essentially continuous external surface. This
20 indicates to the hand of the operator that correct alignment of
21 the contacts has been achieved.

1
2 ADVANTAGES OF CORDLESS SURGICAL HANDPIECES

3 Orthopedic surgical instruments are widely used in many
4 delicate bone working procedures. These include spinal
5 surgeries, neurosurgeries and other bone sculpting operations.
6 For these surgeries, a small, light weight, well balanced

1 instrument is desired. The handpiece needs to have high speed
2 and power, and be sterilizable.

3 The ergonomics of a pencil grip cordless instrument is
4 quantifiably better than corded or pistol grip handpieces.
5 Pencil grip allows more, fine motor control and easier eye-hand
6 coordination. The improved ergonomics of the pencil grip results
7 in less fatigue by the user.

8 A cordless handpiece is more mobile than a corded unit.
9 This makes it easier to pass it around the surgical site, from
10 physician to attendant or assistant. A cordless system is also
11 not weighed down by a cord. The back of corded or pistol grip
12 handpieces can require tugging or lifting of the handpiece
13 cutting tool, which makes cutting more difficult. The cord
14 diameter is very thick for a high performance system, which again
15 limits mobility.

16 A further disadvantage of a corded instrument is that it is
17 tethered. The handpiece can only be operated at a given distance
18 from the console, restricted by the length of the cord. The cord
19 also has associated inductance and capacitance properties which
20 can affect the handpiece performance or electrical complexity of
21 the system.

22 For movement about the surgical site with a corded
23 handpiece, extra cord is needed. The extra cord is either coiled
24 by the physician, held by an attendant or attached to a surgical
25 stand. This coiling necessitates extra labor by operating room
26 (OR) personnel, takes up critical surgical site space and limits
27 mobility of other OR personnel.

28 The mobility and transport of cordless, pencil grip
29 instruments is of particular advantage when multiple instruments

1 are needed in a procedure. This is often the case where
2 drilling, sawing and wire driving are all needed. These often
3 come in rapid succession and in different sequences. Time is a
4 critical factor for successful surgical outcomes.

5 ELECTRICAL ADVANTAGES OF CORDLESS INSTRUMENTS

6 Instrument performance is of critical importance in surgical
7 procedures. A key electrical factor with corded handpieces is
8 the cord itself. The power cord has a given length associated
9 with it and electrical properties of its own.

10 The internal impedance of the cord increases electrical
11 losses and reduces power and performance. The power is lost as
12 heat and many have other electro - magnetic interference (EMI)
13 problems associated with it. The length of cord and flexibility
14 needed usually necessitate the use of three-phase current.

15 The cord also has associated inductance and capacitance
16 properties which reduces performance and necessitates more
17 complex electronics in the console. There are also associated
18 EMI problems with this inductance and impedance. These factors
19 exist with both DC and, especially, AC signals.

20 The electrical properties of the cord are directly
21 proportional to its length and can only be minimized by
22 shortening the cord or making it thicker. A shorter cord reduces
23 mobility. A thicker cord reduces flexibility and increases
24 costs.

25 The EMI problems associated with a cord occur along the
26 entire cord length. The two connections are especially prone to
27 emissions. Cordless instruments, on the other hand, run on
28 direct current (DC), have only one connection point and minimized
29 electronics. The basic level of emitted EMI from the battery to

1 handpiece connection, in a cordless handpiece, is zero.

2 A corded surgical instrument has a direct connection between
3 the patient and wall or line voltage. Power surges from the
4 outlet must be properly controlled before they reach the patient.
5 A cordless instrument which operates with lower voltage, less
6 energy, and a limited capacity power supply, poses a much lower
7 electrical threat to the patient.

8 The calibration and preventive maintenance costs associated
9 with a corded handpiece console are not a factor with a cordless
10 system. The elimination of the console results in more operating
11 room table space. This valuable space can then be used for
12 important instruments and equipment which need to be close at
13 hand.

14

15 COST AND RELIABILITY OF CORDLESS SYSTEMS

16 The cost and reliability of any surgical instrument is of
17 critical importance. OR expenses are high and are based on time
18 usage. All general surgeries have a time factor based on how
19 long the room is occupied and the patient is under anesthesia.
20 Instrument systems must properly work or the operation's success,
21 and thus the patient's health, will be affected.

22 Cord breakage or damage is a prevalent problem and
23 necessitates cord replacement or repair. Cord failure may also
24 damage the handpiece and/or console through electrical shorts or
25 otherwise. Even partial failure will directly decrease the
26 performance of the surgical system. Cord repair and replacement
27 is expensive, as is system repair and replacement.

28 Due to the high failure rate of cords, as well as their
29 importance to the handpiece system, they must be tested often.

1 This results in time and expense to the medical facility, even
2 when they are functional.

3 Cord damage may result in heat build-up or exposed
4 electrical leads. These pose serious risks to the operators as
5 well as the patient.

6 Sterilization and cleaning using hospital grade detergents
7 have serious negative effects on the cord. These thermal and
8 chemical agents directly reduce the life of the cord, as well as
9 increase the likelihood of damage.

10 Cord damage may also result in improper system
11 communications and linkage. This may result in increased cord
12 impedance and consequent loss of handpiece performance. Improper
13 signaling may also lead to improper motor operations and result
14 in handpiece overheating. This may be a hazard to either the
15 user, patient or attending personnel.

16

17 ADVANTAGES OF DISPOSABLE BATTERY PACKS

18 The high operating costs of surgical arenas and medical
19 personnel dictate the use of low maintenance, easy to use
20 equipment. Many times this means single use or disposable
21 components. Also supporting disposable product use is the issue
22 of sterility and contaminants from the surgical site. Surgical
23 equipment is often made disposable whenever possible. Packaged
24 pre-sterile, disposable medical equipment, by its nature, is easy
25 to use and maintain and often very cost-effective.

26 Disposable, primary battery packs offer a higher energy
27 capacity per volume than equivalent rechargeable batteries. The
28 batteries are smaller, which is a distinct advantage in cordless
29 surgical handpieces.

1 Disposable, primary battery packs offer a higher energy
2 capacity per weight than equivalent rechargeable batteries. The
3 batteries are lighter, which is a distinct advantage in cordless
4 surgical handpieces.

5 Disposable batteries are inspected at the manufacturer by
6 trained personnel prior to each use. This gives the products a
7 higher reliability per use than equivalent reusable batteries.
8 This is an advantage during critical use situations that often
9 occur in the operating room.

10 Every battery pack has full running power immediately upon
11 attachment. Rechargeable batteries, on the other hand, must be
12 tested to verify their immediate charge capacity.

13 Due to the nature of disposable batteries there is no pre-
14 or post operation clean-up involved. This reduces the amount of
15 time hospital personnel need to service the equipment.

16 Reusable batteries will exhibit wear after repeated use.
17 This results in debris build-up on components, particularly
18 oxidation on electrical contacts, weakening of the housing and
19 general degradation. This may result in poor or unacceptable
20 product performance. Disposable products do not have these
21 associated problems.

22 Disposable, primary batteries may be entered into the normal
23 waste stream. Standard rechargeable batteries are considered
24 toxic and must be properly disposed of outside the normal waste
25 stream.

26 Most disposable primary batteries may be transported by air
27 or other standard methods. Some types of rechargeable batteries
28 need special handling conditions and permits to be safely
29 transported.

1 By their very nature disposable primary battery cells have
2 an immediate charge capacity, unlike rechargeable battery cells.
3 Rechargeable batteries need to be charged on specialized and
4 dedicated chargers. This is an expensive and bulky piece of
5 equipment for the medical facility.

6 Rechargeable, secondary batteries need to be recharged
7 immediately prior to each use because they lose their electrical
8 charge very quickly. Primary batteries retain their charge for
9 very long periods of time, over ten years. This results in lower
10 service and maintenance costs to hospital for disposable
11 batteries.

12 Primary batteries have a much lower cost base than
13 equivalent rechargeable batteries. This usually has the
14 advantage of saving money for medical facilities.

15 Disposable primary cells generally have a higher voltage,
16 and thus a higher energy potential than rechargeable cells.
17 Furthermore, a higher voltage allows most standard electrical and
18 electromechanical components and motors to operate more
19 efficiently, with fewer components, at a lower cost.

20 Disposable, primary batteries retain their charge capacity
21 under more varied conditions, including thermal, humidity and
22 mechanical (e.g. vibration or shock) than equivalent rechargeable
23 battery cells. This increased robustness is an advantage in
24 surgical operations.

25 In improper use conditions, such as a short circuit, many
26 types of batteries will vent their internal electrolyte in the
27 form of a gas. If, due to improper conditions, primary batteries
28 vent internal gas, these gases are non-toxic. This is unlike
29 some types of rechargeable batteries. That can be a critical

1 issue in an operating room where it would be very difficult to
2 evacuate the area if this condition arose.

3

4 ALTERNATE EMBODIMENT

5 In the alternate embodiment of the present invention as
6 shown in Fig. 13, the handpiece 10' has a rather long-handled
7 trigger 16'.

8 While the presently preferred embodiment of the invention
9 has been disclosed in detail in order to comply with requirements
10 of the patent laws, it will be understood by those skilled in the
11 art that some variations may be possible within the concept of
12 the invention. It will therefore be understood that the scope of
13 the invention is to be determined only in accordance with the
14 appended claims.

15 WHAT WE CLAIM IS: